Quantifying population exposure to airborne particulate matter during extreme events in California due to climate change

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Abstract:

The effect of climate change on population-weighted concentrations of particulate matter (PM) during extreme pollution events was studied using the Parallel Climate Model (PCM), the Weather Research and Forecasting (WRF) model and the UCD/CIT 3-D photochemical air quality model. A "business as usual" (B06.44) global emissions scenario was dynamically downscaled for the entire state of California between the years 2000-2006 and 2047-2053. Air quality simulations were carried out for 1008 days in each of the present-day and future climate conditions using year-2000 emissions. Population-weighted concentrations of PM0.1, PM2.5, and PM10 total mass, components species, and primary source contributions were calculated for California and three air basins: the Sacramento Valley air basin (SV), the San Joaquin Valley air basin (SJV) and the South Coast Air Basin (SoCAB). Results over annual-average periods were contrasted with extreme events. The current study found that the change in annual-average population-weighted PM2.5 mass concentrations due to climate change between 2000 vs. 2050 within any major subregion in California was not statistically significant. However, climate change did alter the annual-average composition of the airborne particles in the SoCAB, with notable reductions of elemental carbon (EC; -3 %) and organic carbon (OC; -3 %) due to increased annual-average wind speeds that diluted primary concentrations from gasoline combustion (-3 %) and food cooking (-4 %). In contrast, climate change caused significant increases in population-weighted PM2.5 mass concentrations in central California during extreme events. The maximum 24-h average PM2.5 concentration experienced by an average person during a ten-yr period in the SJV increased by 21% due to enhanced production of secondary particulate matter (manifested as NH_4NO_3). In general, climate change caused increased stagnation during future extreme pollution events, leading to higher exposure to diesel engines particles (+32%) and wood combustion particles (+14%) when averaging across the population of the entire state. Enhanced stagnation also isolated populations from distant sources such as shipping (-61%) during extreme events. The combination of these factors altered the statewide population-averaged composition of particles during extreme events, with EC increasing by 23 %, nitrate increasing by 58%, and sulfate decreasing by 46 %.

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Resource Description

Climate Scenario : ☑

specification of climate scenario (set of assumptions about future states related to climate)

Other Climate Scenario

Other Climate Scenario: business-as-usual (B06.44) global emissions scenario as part of the IPCC 4th Assessment Report (AR4)

Exposure :

weather or climate related pathway by which climate change affects health

Air Pollution

Air Pollution: Particulate Matter

Geographic Feature:

resource focuses on specific type of geography

Valley

Geographic Location:

resource focuses on specific location

United States

Health Impact:

specification of health effect or disease related to climate change exposure

Health Outcome Unspecified

Model/Methodology:

type of model used or methodology development is a focus of resource

Exposure Change Prediction

Resource Type:

format or standard characteristic of resource

Research Article

Timescale:

time period studied

Medium-Term (10-50 years)